

to sudden shocks or slow disruption, were produced with such irresistible force as to preserve their linear character and parallelism through rocks of the most diverse nature, and even across old dislocations having a throw of many thousand feet. Yet so steadily and equably did the fissuring proceed over this enormous area, that comparatively seldom was there any vertical displacement of the sides. We rarely meet with a fissure which has been made a true fault with an upthrow and downthrow side.

The next feature is the rise of molten basalt up these thousands of fissures. The most voluminous streams of lava that have issued from any modern volcanic cone appear but as a minor manifestation of volcanic activity when compared with the filling of those countless rents over so wide a region. Mining operations in the Scottish coal-fields have shown that dykes do not always reach the surface. In all parts of the country, too, examples may be observed of breaks in the continuity of dykes. The same dyke vanishes for an interval and reappears on the same line, but is doubtless continuous underneath. What proportion of the dykes ever communicated with the surface at the time of their extrusion is a question that may perhaps never be answered. It is difficult to believe that a considerable number of them did not overflow above ground even far to the east of the main and existing outflows. But so extensive has been the subsequent denudation that all trace of such superficial emission has been removed. The general surface of the country has been lowered by sub-aërial waste several hundred feet at least, and the dykes now protrude as hard ribs of rock across the hills.

Traced westwards the dykes increase in abundance, till at last they reach the great basaltic plateaux. Macculloch long ago sketched them in Skye, rising through the Jurassic rocks and merging into the overlying sheets of basalt. Similar sections occur in the other islands and in the north of Ireland. The lofty mural escarpments presented by the basalt plateaux once extended far beyond the limits to which they have now been reduced. The platform from which they have been removed shows in its abundant dykes the fissures up which the successive discharges of lava rose to the surface, where they overflowed in wide level sheets like those still so fresh and little eroded in Western North America.

That there were intervals between successive outpourings of basalt is indicated by the occasional interstratification of seams of coal and shale between the different flows. These partings contain a fragmentary record of the vegetation which grew on the neighbouring hills and which may even have sometimes found a foothold on the crumbling surface of the basalt floor until overwhelmed by fresh floods of lava. Not a trace of marine organisms has anywhere been found among these interstratifications. There is every reason to believe that the volcanic eruptions were all sub-aërial. Sheet after sheet was poured forth over the wide valley between the mountains of Donegal and the Outer Hebrides on the one side and those of the north-east of Ireland and the west of Scotland on the other, until the original surface had been buried in some places 3000 feet beneath volcanic ejections.

I believe that the most stupendous outpourings of lava in geological history have been effected not by the

familiar type of conical volcano, but by these less known fissure-eruptions. Both types are of course only manifestations in different degrees of the same volcanic energy. It is by no means certain that the "massive" or fissure type belongs wholly to former geological periods. In particular one is disposed to inquire whether the great Icelandic lava-floods of 1783—the most voluminous on record—may not have been connected rather with the opening of wide-reaching fissures than with [the emissions of a single volcanic cone. The reality and importance of the grander phase of volcanism marked by fissure-eruptions have been recognised by some of the able geologists who in recent years have explored the Western States and Territories of the American Union. But they have not yet received due acknowledgment on this side of the Atlantic, where the lesser type of cones and craters has been regarded as that by which all volcanic manifestations must be judged. We are fortunate in possessing in the north-west of Europe so magnificent an example of fissure-eruptions, and one which has been so dissected by denudation that its whole structure can be interpreted. The grand examples on the Pacific slope of America have yet to be worked out in detail, and will no doubt cast much fresh light on the subject, more especially upon those phenomena of which in Europe the traces have been removed by denudation. But the other continents also are not without their illustrations. The basaltic plateaux of Abyssinia and the "Deccan traps" of India probably mark the sites of some of the great fissure-eruptions which have produced the lava-fields of the Old World. In their recent admirable *resumé* of the "Geology of India," Messrs. Medlicott and Blanford describe the persistent horizontality of the vast basalt-sheets of the Deccan, the absence of any associated volcanic cones or the least trace of them in that region, and the abundance of dykes in the underlying platform of older rocks where it emerges from beneath the volcanic plateaux. They confess the difficulty of explaining the origin of such enormous outpourings of basalt by reference to any modern volcanic phenomena. Their descriptions of these Indian Cretaceous lava-floods might, however, be almost literally applied to the Miocene plateaux of North-western Europe and to the Pliocene or recent examples of Western North America.

ARCH. GEIKIE

THE ATOMIC THEORY

The Atomic Theory. By Ad. Wurtz, Membre de l'Institut, &c. Translated by E. Cleminshaw, M.A. (London: C. Kegan Paul and Co., 1880.)

THE latest addition to the International Scientific Series is at once a scientific treatise and an artistic work. The translator has very fairly maintained the clearness and crispness of the French style, whereby the book is marked with a distinct individuality and self-completeness.

The sharpness of the impression which this work produces on the mind is gained without making any great sacrifice of accuracy, although it must be confessed there is, in some chapters, a lack of detailed facts, which is against the value of the work as a reference book for the advanced student; and in others there is too free a use of fancy, which faculty is not synonymous with that

other without which no great scientific work can be produced, viz., imagination.

The work is divided into two books: the first, and most valuable, treating of "Atoms," the second of "Atomicity." The historical introduction is very full, and remarkable for the clear exposition of the work of Richter, which was of so much importance in the subsequent development of the doctrine of atoms. The error, which is still fallen into in some books, of attributing the "law of proportionality" to Wenzel is pointed out and corrected.

Full justice is not done to the work of Avogadro, on which, confirmed as it has been by physical evidence, rests the structure of modern chemistry. The distinction between "integral molecules" and "elementary molecules" was clearly stated by Avogadro in 1811, three years before the date of the publication of Ampère's letter to the Comte Berthollet. Ampère's attempt to extend the hypothesis to facts concerning crystalline bodies cannot be regarded as an improvement on the simpler conception of Avogadro.

But throughout this work there is a manifest resolve to abate no jot nor tittle of that assertion, which, made with the plenary knowledge of a chemical Philistine, sounded the keynote of M. Wurtz's well-known "History of the Atomic Theory."

The statement on p. 42 of the reasons for adopting H_2 as the standard of molecular weights is neither clear nor satisfactory. The student might readily suppose that this standard is adopted simply for the sake of convenience; he might also be led to regard the statement of Avogadro's law, on this page, as a deduction from some vaguely-expressed relations between the number of atoms in elementary molecules and the volumes occupied by these atoms.

Few text-books make clear the fundamental deficiency of the Daltonian theory, viz., the absence of any trustworthy means for determining the weights of the "atoms" (or as we now say, molecules) of compound bodies. Dalton, and Berzelius after him, laid down rules for determining these weights, but the rules of both chemists were wholly empirical. "The atomic weight of an element is the smallest amount of that element which combines with unit-weight of hydrogen to form an atom of a compound," but so long as the "atom" of the compound was undefined, the atomic weight of the element could not be determined.

Avogadro furnished chemists with a means of determining the molecular weights of all gasifiable bodies; and in modern chemistry determinations of molecular weights of many compounds of a given element, and analyses of these compounds, must precede the determination of the atomic weight of the element itself.

The atomic weight of an element is the smallest amount of that element—referred to hydrogen as unity—contained in the molecule, that is in two gaseous volumes of any compound thereof. For lack of a clear differentiation between atom and molecule, and for lack of a definite statement of how atomic weights are determined, the full and valuable table, extending from p. 104 to 109, loses much of its meaning. This table, by the way, very closely resembles a table which occurs in Lothar Meyer's "Die modernen Theorien"; the alterations made by M. Wurtz certainly do not add to the value of the table.

Dalton's objections to the generalisation of Gay Lussac, that "equal volumes of gases contain equal numbers of atoms," was, as we now know, perfectly justifiable, but on p. 35 Dalton is said to have repudiated "the solid support which the great French chemist gave to his ideas."

Gay Lussac's generalisations could not be true, said Dalton, because of such a reaction as that between nitrogen and oxygen, wherein equal volumes of each combine, and the product, nitric oxide, measures twice the volume of either; that is, there are, according to Gay Lussac, twice as many atoms of nitric oxide as of oxygen or nitrogen; but as elementary atoms are chemically indivisible, this is impossible. Berzelius obviated, or rather shirked, the difficulty by applying Gay Lussac's generalisations to elementary gases only, but a full reconciliation between the views of Dalton and those of Gay Lussac was only possible when Avogadro's fruitful idea of the existence of molecules as distinct from atoms was fully recognised in chemical science.

In describing the physical methods for checking atomic weight determinations, the law of Dulong and Petit is stated in too absolute a manner; if the data concerning the specific heats of the elements are carefully considered, it is evident that in many cases the value varies very much with temperature, that in others no direct determination of specific heat has yet been made, and that the law cannot be regarded as a final statement of the connection between the specific heats and atomic weights of the elements.

The state of our knowledge with regard to the structure of molecules, indeed, renders a full understanding of specific heat at present impossible. The dynamical theory of gases has not yet been fully worked out in this direction.

Although the "law of Avogadro" is a deduction from the dynamical theory of gases, and as such is invested with an authority which no mere collection of empirical facts can bestow upon it, yet nowhere in M. Wurtz's book is this insisted upon.

The compromise between an atomic and an equivalent system of notation, which was so long adopted by chemists, is well described and its evils fully laid bare.

The objectors to Avogadro's law are more numerous and more important in France than in this country or in Germany, hence M. Wurtz devotes considerable space to the subject of dissociation, which he discusses with much clearness and wealth of illustration.

The demonstration on pp. 121-123 of the monatomic character of the mercury molecule is admirable.

In the list of names of those who have pointed out relations between the atomic weights of elements and properties of their compounds, there is a serious omission, viz., the name of A. R. Newlands. This subject of relation between atomic weights and properties of compounds is discussed on pp. 154-176. A better idea of Mendelejeff's "periodic law" may be obtained from these pages than probably from any other English text-book, but surely it would have been well had the author more explicitly acknowledged his indebtedness to Lothar Meyer's work. The graphic representation of the relations between the atomic weights and physical properties of the elements—taken from Meyer's book—has not hitherto been in the hands of the English student.

The second part of M. Wurtz's book, dealing with Valency, is not, in our opinion, of equal value with the first.

After reading these chapters one finds it hard to find a reason for introducing into science the conception of valency, so variable and shifting is this property of atoms made to appear.

On p. 229 it is stated that chlorine is monovalent in HClO , pentavalent in HClO_2 , and heptavalent in HClO_3 .

Scarcely a hint is given of the many objections to extending considerations concerning valency, in any but a most tentative manner, to non-gasifiable bodies. The theory of molecular as distinct from atomic compounds is dismissed; all are regarded as atomic, and the valencies of the atoms seem variable at pleasure. Where proof of the valency of atoms is not forthcoming, assertion is used in its place.

The author's treatment of affinity is not satisfactory. "Affinity is the force of combination, chemical energy." "Atoms attract each other, and this atomic attraction is affinity." "Thus we know that while hydrogen is united to chlorine with extreme energy, oxygen combines with less force." Surely the translator is to blame for some of these sentences.

The theory of valency deserved a more rigorous and exact treatment than M. Wurtz has given it.

We leave the book, feeling that it is the production of a brilliant author, not the work of a deep thinker.

M. M. P. M.

NEW ZEALAND MOLLUSCS

Manual of the New Zealand Mollusca. By Frederick Wollaston Hutton, F.G.S. Published by command. (Wellington, 1880.)

IN an interesting article which appeared in NATURE, vol. xxii, p. 461, entitled "The New Zealand Institute," attention was called to the publications of the Institute and to the excellent work in science achieved by the author of the manual above mentioned, and by many other naturalists, as well by geologists, chemists, astronomers, archæologists, physicists, and philosophers. When the traditional New Zealander visits the ruins of the old country, it is to be feared that he will lament our ignorance instead of expressing his admiration of our past eminence.

Prof. Hutton seems to have contributed to the publications of the Institute a number of valuable papers on "the various divisions of the fauna of New Zealand." We are not quite sure that our knowledge of any one department of the fauna would be so much advanced by a multifarious zoologist as by a specialist who has devoted himself to the study of that department. The division of labour is not less desirable in natural history than in other equally extensive fields of work. The material is so vast that a Linné, Buffon, or Cuvier would be now rather an anachronism than a marvel.

The present work is called "A Systematic and Descriptive Catalogue of the Marine and Land Shells, and of the soft Mollusks and Polyzoa of New Zealand and the adjacent Islands." It belongs to the Colonial Museum and Geological Survey Department, of which Dr. Hector, the well-known geologist, is the director. Its scope is

most useful; and, as the preface by Dr. Hector very properly states, "an accurate knowledge of the affinities and distribution of the recent shells of New Zealand is a very necessary element in the geological survey of the country, as it must form the basis of our Tertiary geology, upon the correct deciphering of which many questions of the highest interest depend." And he adds, "Shells afford the most reliable data for palæontologists; but before the extinct shell-fauna can be utilised, the recent shells of the area must be thoroughly determined." This is quite true. We are disposed, however, to carry the process a step further. It is not enough to determine or make out the recent shells, but they must be critically compared with their fossil analogues. For want of such comparison the late Prof. Nyst, M. Vandenbroeck, and other Belgian palæontologists have unfortunately caused some confusion by a wrong identification of recent or living species with Tertiary species.

The "Manual" contains 237 pages. There are no plates or illustrations. It appears to comprise all that is known of the subject, and to have been conscientiously and on the whole carefully written. But, like all other books, it is not faultless. In the Bibliography "Linneus" is the name given as the author of the 12th edition of the "Systema Naturæ." It ought to be "Linné," according to the title-page and dedication. "Gastropoda" is now the usual, as well as correct, spelling of the class, not "Gasteropoda." The shell of the family *Patellidae* is not a simple cone, but is spiral in the young. The *Bullidae* are not all eyeless. The sub-order "Lucinacea" is described as having the gills, "one on each side"; but in one of the families of this sub-order there are "two gills on each side." The family "*Radulidae*" is stated to have the foot "not byssiferous"; *Limahians* with its foot spins a byssus and makes its curious nest. In the "Artificial Key to the Marine Shells" the remarkable class *Solenocoenchia* (or as Prof. Hutton in another place prefers to call it, "Scaphopoda") is omitted. The shell in "*Capulidae*" is described as "not spiral." These and other less important errors can be corrected in a future edition. We regret, but are not surprised, to see the remark that "not much dependence can be placed on the localities in Mr. Cuming's collection," which was purchased for the British Museum at a large price. This is the case with all dealers, and it sadly disturbs our ideas of geographical distribution. We are inclined to question even such species as *Ostrea edulis*, *Mytilus edulis* and *Lucina (Loripes) divaricata* as indigenous to New Zealand. These are included in a list of sixty-four species believed by the author to be the only New Zealand species of which there is evidence that they are found anywhere else, although he admits that the identification has in most cases been made solely by descriptions and figures. The same remark applies to *Cypraea europaea*, "*Philippia lutea*" = *Solarium hybridum*, *Littorina cærulescens* = *ueritoides*, and *Crepidula unguiformis*. But, *per contra*, the *Saxicava australis* of Lamarck is scarcely a variety of *S. rugosa*, Linné. The diagnosis of the soft parts, or "animal," of *Vitrina* and *Succinea*, viz., "too large to enter the shell," does not suit the European species of those genera. In the family *Assiminiidae* the eyes are placed not "on the middle of the tentacles," but on their tips. "*Odostomia lactea*" is not the Linnean species of